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NEW DATA ON SOLAR ACTIVITY AND ITS
INFLUENCE ON THE EARTH

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SUMMARY

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This paper reviews the new solar data provided by the Kislovodsk Astronomical station of the Main Astronomical Observatory of the USSR Academy of Sciences. The author asserts that measurements of the outer layers of the solar atmosphere were more precise at that station than at any other of the eight world stations. Several aspects of solar-terrestrial relationships are discussed, including the biophysical effects on human beings.

author

* * *

Intense fluxes of ultraviolet, X-ray, radio and charged particle emissions emerge from the active regions of solar atmosphere. Reaching the Earth's atmosphere, these emissions induce variations in the ionosphere, leading to disruption of radiocommunications, occurrence of magnetic storms, aurorae, induced currents interfering with the operation of the various means of communication and signalization. The recently conducted investigations leave no doubt about the significant role of the indicated radiations in climatic and weather processes. More and more proofs are accumulated about the fact, that the biological processes too are subject to solar activity, including the human organism. Particularly great is this effect upon humans located beyond the limits of the atmosphere during space flights.

* NOVVIYE DANNIYE O SLONECHNOY AKTIVNOSTI I YEYE VLIYANIYE NA ZEMLYU.

The investigation of all processes taking place in the Sun's atmosphere is being carried out at the mountain station near Kislovodsk in the Caucasus (Fig.5).^{*} Optical devices as well as radiotelescopes are used to that effect. Analysis of the results of observations accumulated at the station led to conclusions, compelling us to modify our concepts of the 11-year solar activity cycle, as a result of which we could discard certain contradictions having arisen during the study of solar-terrestrial relationships.

Here new possibilities appeared owing to the fact, that brightness measurements of outer layers of the solar atmosphere — the corona, taking place at our station, were found to be the most precise and, photometrically the most stable by comparison with the data of the remaining eight analogous stations existing in the world. This is made evident from the following table of green line 5303 Å intensity ratios according to the determinations of the Kislovodsk station (K), American stations at Sacramento and Climax peaks (A), the French station Pic du Midi (P). Ratios for every half year are compiled in the table.

As may be seen from the table, the ratio P/K was constantly equal in 1962. This means, that then the measurements in Kislovodsk and at the Pic du Midi were about identical in absolute magnitude. Since measurements at both stations were conducted entirely independently, the similarity of the data is evidence of closeness to true values. Beginning with 1962 (and even as of 1961) the ratio P/K rises and is doubled by 1963. This means that the photometric system began to change at either

TABLE

Years	K/A	P/K
1957	—	—
	1,2	1,0
1958	1,1	1,1
	1,2	1,0
1959	1,4	0,9
	1,6	0,8
	1,7	0,9
1960	1,5	1,0
1961	1,5	1,2
	1,5	1,2
	1,6	1,6
1962	1,6	1,7
	1,9	1,8
1963	1,7	2,0

or both of these stations. Inasmuch as the ratio of the Kislovodsk data did not systematically vary since 1960 (K/A), the increase of the P/K ratio took place during the last few years on account of the variation of the photometric system at Pic du Midi. Similarly, the constance of the ratio P/K to 1961 is evidence that K/A became different at boundary

* [at the end of the text]

between 1958 and 1959, in connection with the application of a new method of measurements at American stations.

By way of comparison of data of various stations it is possible to derive a series of values of corona intensity, which reflect only the variations taking place in the Sun and are not dependent on variations in the apparatus or measurement methods. Owing to that it was possible to involve the information on solar corona for the investigations of the 11-year solar activity cycle; this was of significant value, inasmuch as contrary to the remaining events on the Sun (sunspots, flocculi, flares), which occur only in the narrow heliographic latitude interval and are as discrete in time as at Sun's surface, the corona can be observed at any latitudes and its intensity distribution along the Sun, as a function of time, can be traced continuously.

Prior to taking into account the new data it was estimated, that every 11-year cycle of solar activity opens by a valid rise during 3-4 years to a maximum and then ends by gradual drop during 7-8 years to a minimum. At the same time, each new cycle begins at high latitudes in both hemispheres, gradually shifting to the equator as the cycle unfolds (the Shperer law*). These regularities in solar activity development were considered as solidly established and their explanation, or, at the very least, the absence of contradiction constituted a compelling condition for any theory.

In comparing the data on solar activity with various geophysical events one may naturally expect that the latter must, if only in their general traits, reiterate the 11-year curve of solar activity. In the opposite case there would be little ground to assume, that either geophysical event is conditioned by solar activity.

Our data on the solar corona have permitted to establish that two, and not one, maxima of solar activity develop in the course of the 11-year cycle, substantially differing by their properties. During the first maximum we observe an increase in the intensity of corona glow simultaneously in the whole Sun, from the equator to the poles, although the highest intensity of all is observed at the 25° latitude of every hemisphere. The sunspot formation activity also encompasses the greatest latitude interval during the same lapse of time. Then the activity of the first maximum decreases and the second maximum begins to develop, but only

* in transliteration

in the equatorial regions, the highest intensity being at about 10° in both hemispheres. Although the activity during the second maximum encompasses only the equatorial part of the solar surface, this second maximum is still equal to the first one by the aggregate corona intensity, and, by way of consequence, by the amount of radiation emitted by active regions.

Such concept of the development of the 11-year cycle of solar activity is in a considerably better agreement with the numerous facts assembled during the observations of solar eclipses than with the earlier data. The broad data on sunspots, published in 1874 by the Greenwich Observatory, confirm the conclusions derived on the basis of observations of the solar corona. Analysis of these data was jointly conducted by the mountain station near Kislovodsk and the Skal'nato Pleso Observatory of the Slovakian Academy of Sciences.

It is now evident that the curves, having earlier characterized the 11-year solar activity cycle, constitute in fact the result of superimposition of curves related to the first and second maxima.

The corona observations at the Kislovodsk station, to which now the observations of all coronal stations of the world are referred, will constitute the empirical basis for future theoretical investigations of solar activity. However, these observations have already permitted to arrive now at important conclusions concerning the dependence between solar and geophysical events.

It has been known for a long time that the state of the upper layers of the Earth's atmosphere and the phenomena connected with it, such as variations in the ionosphere, condition of radiowave propagation, geomagnetic disturbances and aurorae) are entirely conditioned by processes taking place in the Sun. However, one thing was still obscure, that is, why these events reveal a more or less sharply expressed second maximum which is absent in the 11-year curve for the number and surface of sunspots.

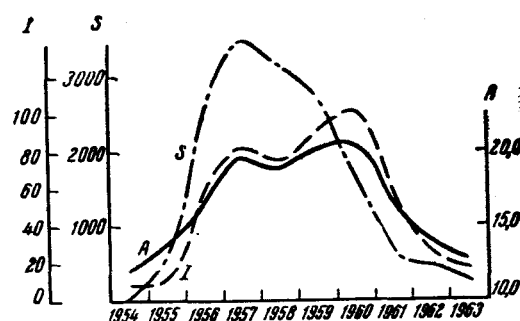


Fig. 2. - Comparison of the sunspot surface S and the intensity I of the solar corona with the geomagnetic activity A (according to Gnevyshev and Olyu).

This contradiction is entirely eliminated by the coronal data. We plotted by solid curve of Fig. 2 (A) the variations of Bartels' planetary index of geomagnetic disturbances in the course of the last 11-year cycle. The interrupted curve I indicates the aggregate emission of the corona in a cone of 60° angle, whose axis is directed toward the Earth. The correlation factor between these curves is $+0.98$. The dashed curve S characterizes the variation of sunspot surface during that time; it corresponds to earlier representations of the development of the 11-year cycle.

The so-called polar region absorption (PCA) is a very important event: it is a complicated aggregate of processes including the reinforcement of the proton component of solar radiation. In the left-hand part of Fig. 3 we indicated by the solid curve the number of PCA cases by years, and by dashed curve — the aggregate intensity of the solar corona about the whole disk. The role of the second maximum is clearly seen.

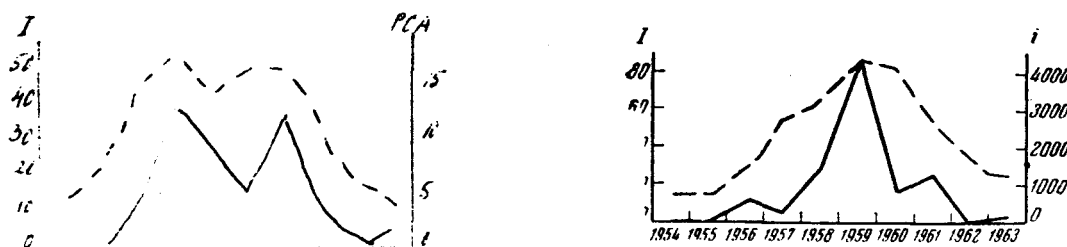


Fig. 3.- Left — comparison of the aggregate intensity about the entire Sun of the green coronal line (dashed curve) with the number of PCA cases. In the right-hand part the dashed curve shows the aggregate intensity of the green coronal line in a cone 10° wide, with the axis directed at the Earth. The solid curve shows the intensity of the proton component of solar emission.

The value of the second maximum becomes still more substantial if one examines the way the intensity of the proton component varied during that time (solid curve *i* in the right-hand part of the figure). The dashed curve of the right-hand part of the figure is the intensity of the corona in a cone 10° wide, with axis directed at the Earth. Hence, it follows that proton fluxes of solar origin are narrow.

Of particular importance is the question of the possibility of long-range weather forecasting (several months or years ahead), if only in fairly general traits. To-date, not only the very method of forecasting

has not been available, but even physical foundations, upon which one could start for its creation, are unknown. Such foundation could be found in the solar activity if it could be proven that it is conditioning processes not only in the upper, but also in the lower layers of the atmosphere. A great number of investigations were made with the view of founding a proof of it, but the resulting data were controversial. This led to the opinion, that the lower layers of the Earth's atmosphere constitute a physically closed system.

In a work, recently published by B. I. Sazonov (Main Geophysical Observatory) it was established on the basis of data of world aerological synoptic maps, that place of formation of cyclones and anticyclones are disposed in a circle, in the center of which is the Earth's geomagnetic pole. Consequently, the occurrence of these phenomena is conditioned by solar corpuscles, which are disposed in an analogous zone under the action of the Earth's magnetic field, creating there the most intense aurorae and geomagnetic disturbances. However, a number of such events in the course of an 11-year cycle revealed the second maximum, absent on the classical curve of solar activity. This contradiction is presently eliminated, since the second maximum in troposphere processes coincides with the second maximum of coronal glow shown in figures 2 and 3.

By the initiative of J. Picardy of the Physico-Chemical Institute of Florence interesting observations began in 1955 of the behavior of colloides in a series of especially equipped stations at various terrestrial latitudes. It was found that certain chemical pastes vary identically at all these stations and reveal a dependence on solar activity. The only "disturbing" factor here was the presence of a second maximum of solar activity on the 11-year curve. As may be seen from Fig. 4, this second maximum (solid curve) corresponds to the same time as the second maximum for the corona glow (dashed curve). A special international organization was created in 1963 for the investigation of the events of sudden disruptions of standard chemical processes.

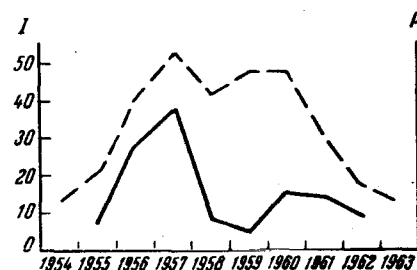


Fig. 4. Comparison of the intensity of the green coronal line, summed up by the entire Sun (dashed line) with the chemical by J. Picardy.

Finally, a broad material has already been accumulated on the variation of blood content (variation in the number of leucocytic series cells), which sometimes take place simultaneously in a great number of people at remote distances from one another. This is evidence that the cause of such variations is external and it is apparently linked with the solar activity. The indicated variations reveal also the second maximum in the 11-year cycle. Evidently, from the physico-chemical stand point these biological processes are linked with the phenomenon discovered by Picardy. Much has been done in that direction in the USSR by the hematologue N. A. Shul'ts. Foreseeing the time of blood content variation and taking appropriate measures may save lives of many people, whose health is in a critical state.

As may be seen from the above, investigations conducted during the IGY, IGC and IGCC have shown, that the role of solar activity in the different events on Earth is significantly greater than had been assumed earlier. In connection with that the value of regular observations of solar activity and the clarification of the induced phenomena has immeasurably increased.

**** THE END ****

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on 1 July 1965



Fig. 5

D I S T R I B U T I O NG O D D A R D S P A C E F . C .

600 TOWNSEND
STROUD
610 MEREDITH
611 McDONALD
ABRAHAM
BOLDT
612 HEPPNER
NESS
613 KUPPERIAN
614 LINDSAY
WHITE
HALLAM
BEHRING
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BAUER
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